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SECTION 236416 - PRE-PURCHASED CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

DESCRIPTION OF WORK

Extent of water chiller work is indicated by requirements of this section.

Types of water chillers specified in this section include the following:

Centrifugal machine -- open or closed, with single compressor.

Electrical: Furnish electrical field-wiring diagrams to installing contractor power wiring and starters for water chiller, and control wiring for field-mounted controls. Wiring will be the responsibility of the installing contractor.

Wiring diagrams shall clearly illustrate the interconnections required between the chiller starter and the chiller control panel. Details shall include, but not be limited to terminal point designations, wire sizes, etc.

WORK BY OTHERS

Under separate contract, the installing contractor will be responsible for receiving, unloading, temporary on-site storage (if needed) and installing the equipment and material at the delivery point as described in the Special Conditions. The chiller vendor shall be responsible for coordination of the delivery and required work (as specified herein) with the installing contractor.

QUALITY ASSURANCE

Regulatory Requirements:

Kentucky Building Code: Chiller shall comply with all relative sections of the latest edition.

ARI Compliance: Provide certified capacity ratings for water chiller in accordance with Air-Conditioning and Refrigeration Institute (ARI) Standard 550/590-98 (hereinafter referred to as “ARI Standard(s)”). NOTE: these specifications take certain exceptions to ARI Standards in selection and testing requirements.

ASHRAE Compliance: Construct refrigerating system of water chiller in accordance with American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard ANSI/ASHRAE 15 "Safety Code for Mechanical Refrigeration". Include all proposed safety features and/or devices required by ASHRAE for refrigerants declared to be toxic.

ASME Compliance: When required by code, construct and test water chiller in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII.

National Testing Approval: Chillers and accessories (where applicable) shall be approved by Underwriter’s Laboratories, Inc. or another nationally recognized testing agency.

SUBMITTALS:

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.

Submittal Drawings: Submit manufacturer drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring required for final installation of water chiller and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Manufacturer shall submit maintenance/operational manuals, and parts list for each water chiller, control, and accessory; including "trouble-shooting" maintenance guide. Include current service/repair/overhaul manuals. Furnish to owner any updated or newly released related materials when available during the first five years of service.

CHILLER OPERATION AND MAINTENANCE MANUALS

Provide five (5) bound final installation, training, operation, maintenance and repair manuals to be turned over to the Owner's Representative and approved for content by the Engineer prior to acceptance of substantial completion.

Manuals provided must be of sufficient detail to enable customer to install, calibrate, train, operate, maintain, service and repair every system, subsystem, and/or piece of equipment installed on or as part of this contract. Manual must contain:

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Project Title, Project number, Location, dates of submittals, names of Engineer, Engineer, Contractor, and Contractor's Sub-contractors. Provide phone numbers and addresses for Contractor and Sub-contractors.

An Equipment Index that includes vendor’s name, address, and telephone number for all equipment purchased on the project.

Emergency instructions with phone numbers and names of contact persons on warranty items.

All manuals in binders shall be original copies provided by the manufacturer. At minimum these binders must include:

- Installation manuals, Calibration manuals
- Training manuals, Operation manuals
- Service Manual, Repair manuals
- Parts list, Wire list
- Reviewed submittals.
- Certification that owner is to receive all published service, repair and overhaul manuals by being placed on the current mailing list.
- Copies of all inspection and guarantee certificates.
- Copies of all manufacturers' warranties as filed for all equipment provided and/or installed, with the “Commonwealth of Kentucky” listed as the owner

Manuals: Bound in hard cover three (3) ring (D-type) binder, 1", 1.5" or 2" maximum, white vinyl, presentation type with clear vinyl view cover on front, back and spine and with pockets on front and back. Contents shall be indexed in CSI format, tabbed (4,5,8 or 16th cut), with no more than 80% binder fill. Maximum drawing size in binder shall be folded 11"x17" and shall be hole punched and reinforcements added. Do not put drawings in pockets. Top of all drawings shall be at top or spine side of the manual. Complete drawings must be viewed without opening rings. Provide binders as manufactured by Universal Office Products, Des Plaines, IL. 1"(S# B2-20742), 1.5"(B2-20744), or 2"(B2-20746) or equal.

If the binder includes manuals from any one vendor covering several different model numbers, the model used on the project must be highlighted.

Required Submittals:

The following chart is supplied for the benefit of the Owner, Engineer and Contractor to assure a complete submission of required

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information. It is a reference listing of documents required by the Specifications under this Section.

ITEM	SHOP DWG.	M & O MANUAL	PARTS LIST	CERTIFICATION
Chiller*	X	X	X	X

* Provide wiring diagrams.

PART 2 - PRODUCTS

WATER CHILLERS -- GENERAL

Provide electric-driven, hermetic or open, centrifugal chillers as specified hereafter. Chillers shall be provided with all parts as necessary for automatic operation.

CENTRIFUGAL WATER CHILLERS:

General

Chiller shall be a complete package, factory assembled and wired. If manufacturer does not provide unit as a complete factory package, then furnish the necessary labor and material to complete the assembly and erection and insulation of the machine in the field.

If an open-drive motor/compressor design is used, the chiller size must be increased to handle the added chilled water load.

Acceptable Refrigerants:

Centrifugal --- R-l34a, R-123

Surging: Chiller shall provide surge-free operation at l00% to 25% capacity at maximum operating conditions specified including, but not limited to, 42 deg. F. leaving chilled water temperature and 85 deg. F. entering condenser water temperature with specified water flows.

Sound: The centrifugal chiller sound pressure level (SPL), in decibels (dB), with a reference pressure of 20 micropascals, shall not exceed the values listed below. All ratings shall be in accordance with ARI Standard 575-94, "Method of Measuring Machinery Sound Within Equipment Rooms".

No reduction of entering condenser water or raising of leaving chilled water temperatures will be allowed in the sound levels. Making such a temperature adjustment does not represent the loudest operating condition the chiller will experience while on the job, and could mask sound problems that would otherwise occur. A minimum of 75% of the sound data points along the length of the machine shall be taken, and established as the minimum percentage of total possible points used to determine sound levels.

Water chiller shall be complete with compressor(s) and motor(s), evaporator, condenser, lubrication system(s), capacity control and controller(s), motor starter(s), instrument and control panel mounted and factory wired on the machine, purge system, mounting isolation and other items as herein specified.

Centrifugal Compressors:

Compressors shall be single or multi-stage centrifugal types. Impellers must be high strength aluminum alloy, balanced both statically and dynamically. Impellers shall be proof tested at least 15 percent above design operating speed.

Automatic capacity control shall modulate performance from 15 to 100 percent of rated unit capacity at design conditions. Compressor shall always start unloaded.

Compressors shall be field serviceable.

Forced-fed lubrication systems with a hermetic motor-driven oil pump shall be furnished as part of the water chiller. System shall be complete with oil pump, oil cooler, pressure regulator, oil filters, thermostatically controller oil heater and necessary motor control. Oil pumps shall be energized prior to chiller motor energization. Oil pump starter shall be factory supplied and mounted on the chiller and factory wired with only field power leads required.

Evaporator and condenser shall be fabricated with high performance integrally finned copper tubing rolled into the tube sheets in both the evaporator and condenser as well as expanded into the tube support sheets in the evaporator. Tubing shall be finned except in the area adjacent to and in contact with the tube and tube support sheets. Tube support sheet shall be spaced at intervals to maintain proper tube spacing and to minimize tube vibration and wear.

Tubes shall be removable from either end of the heat exchanger.

Minimum tube wall thickness shall be 0.028 inches.

Construction and materials for the heat exchangers shall conform to ANSI/ASHRAE 15-1994 Safety Code for mechanical refrigeration (which in turn requires conformance to the ASME Code for Unfired Pressure Vessels where applicable).

Provide true marine water boxes on both ends of condenser and evaporator (hinged heads; removable without disconnection of piping). Provide factory-mounted pivoting gantries at both ends of condenser and evaporator to allow removal of marine water box covers without the need for auxiliary hoists. Hinged, davited marine water box covers that will allow the

cover to be opened and hinged out of the way without disturbing or removing the piping are an acceptable alternative to the pivoting gantries.

Regardless of refrigerant type, unit shall be equipped with a factory-mounted, spring-loaded reseating relief valve designed for exterior venting.

Provide purge system, factory installed, wired and piped; system shall be self-contained. Provide any necessary devices for separating and returning refrigerant to the system.

Low-pressure hermetic chillers (HCFC-123) must have a separate high-efficiency purge system that operates independently of the unit. Include a purge pressure gauge, number of starts counter, and an hour meter in the purge system.

Low-pressure open-drive chillers (HCFC-123) must have a separate high-efficiency purge system. Include a purge pressure gauge, number of starts counter, and an hour meter in the purge system. If purge system does not operate when chiller is off, include a refrigerant warming system to maintain refrigerant at sufficient temperature to prevent negative pressure within the chiller.

Units operating with refrigerants having positive pressure (R-134a) at 75 Deg. F. shall have isolation valves so that chiller has the capability of storing the refrigerant charge in the condenser. Provide the isolating valves at the chiller compressor discharge and the refrigerant liquid line, so that the refrigerant charge can be isolated in the condenser. If the condenser does not have the capacity to store a minimum of 80% of the total refrigerant charge, provide a separate storage receiver.

Demand limiter -- Demand limiter device shall be provided within the standard control panel so that maximum current may be manually set to any fraction between 30% and 100% of full load amperes.

Unit Controller:

The unit shall be equipped with a complete microprocessor control system. This system shall consist of control transformer, temperature and pressure (thermistor and transducer) sensors, Input/Output (I/O) board, power supply board, main processor board and interface board with display and keypad. All devices and sensors shall be factory mounted and wired. These devices shall be capable of self-diagnostics. All sensors shall be hard-wired with quick-disconnect devices for easy removal.

The interface device shall be equipped with individual touch-sensitive membrane key switches.

Control center shall be capable of interfacing via BACnet protocol with a Johnson “Metasys” facility automation system. Required interface points shall provide for remote chiller start/stop; reset of chilled water temperature; reset of current limit; and status messages indicting chiller is ready to start, chiller is operating, chiller is shutdown on a safety requiring reset, chiller is at full load, and chiller is shutdown on a recycling safety. Provide run time meter and start counter.

Provide a 4-20ma or 2-10vdc output signal for refrigerant differential pressure (condenser pressure minus evaporator pressure) to interface to the building control system, if this point cannot be passed through the standard interface listed above.

The chiller shall have the necessary controls to allow the chiller to start with 60^{o}F condenser water temperature and 60^{o}F. return chilled water temperature.

Starters shall be furnished for all auxiliary motors, such as oil pump, purge and transfer unit.

All wiring shall meet or exceed the National Electrical Code (latest edition).

Field-Installed Insulation: The manufacturer shall provide the necessary labor and material to field-insulate each chiller at the project with 0.75” fire retardant flexible closed cell plastic type painted insulation, including heads on evaporator.

Insulation shall be field-painted (under this contract) to match the factory chiller color.

Vibration Isolation: Provide vibration isolation pads for each chiller according to isolator manufacturer’s recommendations.

Motors shall be single-speed, non-reversing squirrel-cage induction type, and shall be suitable for voltage indicated herein. Compressor motor(s) shall be built for connection to Star-Delta/closed transition starters. Motor stator shall be arranged for service or removal without complete compressor disassembly or breaking of main refrigerant piping connections. Full load operation of the motor shall not exceed nameplate rating.

Unit-Mounted Starter:

Unit-mounted starter for chiller compressor motor shall be closed transition, Wye-Delta (Star-Delta) or solid state type starter in a NEMA 1 enclosure. Starter shall be capable of handling the maximum

locked rotor and maximum full load running currents for the size chiller motor. Chiller starter continuous amperage rating shall not exceed the maximum full load amperage rating of the motor provided by the chiller manufacturer.

Provide an overload in each phase set at 104%-107% (per manufacturer's recommendation) of the rated load amps of the connected motor. Overloads shall be manual reset and shall de-energize the main contactor when over current occurs. The overload shall be adjustable and selected for mid-range. The overload relays herein before mentioned shall be ambient temperature compensated manual re-setting bi-metallic type overload relays. Overloads may be electronic for solid-state starters. Provide inherent low voltage protection and inherent motor protection against single phasing and phase reversal on all three legs.

The Wye-Delta starter shall provide 58% starting voltage and shall limit amperage inrush to 33% of locked rotor. Provide starter with the control features (current transformers for load limiter, transformer for chiller controls, relays and interlocks) required by the chiller manufacturer. Starters shall be braced for 65,000 symmetrical amps and shall be UL listed and labeled. Provide inherent low voltage protection and inherent motor protection against single phasing.

Provide an ammeter and voltage meter mounted in chiller starter (or as a part of chiller control panel). Each ammeter shall have a full-scale reading of 1000 amperes with a 5 ampere load. Provide ammeters with selector switch for each phase. In conjunction with each ammeter, provide a current transformer on one leg of each starter. This current transformer is for use by the load limiter.

All bussing, conductors, control wiring, interlock wiring and connectors utilized in the chiller starters shall be 98% conductivity copper.

Provide circuit-breaker/disconnect in each chiller starter.

Chillers shall operate with a minimum power factor of 95 percent. If power factor correction devices are required to meet 95 percent, the manufacturer shall provide the necessary labor and material to install power factor correction equipment for each chiller. Correction equipment may be factory- or field-installed.

Factory-mount chiller starter on the unit.

Chiller starter shall be as manufactured by Square D, Westinghouse, General Electric, Cutler-Hammer or the chiller vendor.

ADJUSTABLE FREQUENCY DRIVES:

Chiller using adjustable-frequency drives (AFD's) are acceptable, and may be proposed at the vendor's option. If adjustable-frequency drives are proposed, the drive electrical losses must be listed in the appropriate space on the Form of Proposal. Such drives shall confirm to the following:

Basic Description:

The adjustable frequency controller (AFC) shall be solid state, with a Pulse Width Modulated (PMW) output waveform. The AFD package as specified herein shall be enclosed in a single NEMA 1 enclosure, completely assembled and tested by the manufacturer. The AFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device (SCR's, GTO's and Darlington transistors are not acceptable). The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.95 at all speeds and loads.

All programmable settings shall be held in non-volatile memory and shall not be affected by power outages, brownouts, power dips, etc.

Codes/Standards:

AFC and options shall be UL listed.

The controller and options shall comply with the applicable requirement of the latest standards of ANSI; NEMA ICS-6 for controls and systems; National Electric Code NEC; IEC 801-2, 801-4, 256-4.

Unit shall be braced for 65,000 symmetrical amps and shall be UL listed and labeled.

Experience:

The manufacturer of the AFC controller described in this specification shall have minimum of 10 years experience in the design, construction and application of adjustable frequency controls and motors.

Quality Assurance:

The AFC controller shall be subject, but not limited, to the following quality assurance controls, procedures and tests.

If other than the chiller manufacturer, the drive manufacturer shall have been actively and continuously engaged in the production of

adjustable frequency controllers for a period of at least 10 years and have experience of at least 8 years in commercial applications.

Adjustable Frequency Controller:

The AFC manufacturer shall provide, at minimum, the electromechanical construction, basic features, adjustments, general options and modifications and special options as outlined in this specification.

Basic Features:

The AFC shall have the following basic features:

The AFC shall incorporate a full alpha/numeric customer interface panel showing all settings, parameters, operating screens, operating data, supervision information and faults in plain English. Display may be incorporated with the chiller control panel.

The optional main input disconnect shall provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.

Harmonic Distortion: The AFD shall not produce more than 5% total harmonic current distortion, measured at the drive input lugs. If a filter or other correction device is required, the resulting electrical losses must be included in the AFC loss calculations in the bid form.

The chiller vendor shall test the current distortion for the installed chiller and provide a written report of final distortion readings.

Protective Circuits and Features:

The AFC shall include the following protective circuits and features:

Fast acting semiconductor fuses specifically sized for protection of the AFC.

Instantaneous Electronic Trip for the following faults:

Output phase-to-phase circuit condition

Total ground fault under any operating condition

High input line voltage

Low input line voltage

Service Conditions:

The AFC shall be designed and constructed to operate within the following service conditions:

Suitable for continuous operation at an ambient temperature of 0°C. to 40°C. Elevation up to 3300 feet altitude with a relative humidity to 95%, non-condensing.

A-C line variation of 414 vac -10% to 508 vac +10% ±2% frequency.

REFRIGERANT VAPOR DETECTOR

Additional refrigerant monitoring/alarm equipment required by ASHRAE 15 – 1994 will be furnished and installed outside of this contract.

Self-Contained Breathing Equipment

Additional safety and breathing equipment required by ASHRAE 15 – 1994 and located outside the limits of the mechanical room will be furnished and installed by the Owner.

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MACHINE-SPECIFIC CHILLER PARAMETERS

Chillers shall be sized, rated and tested in accordance with ARI Standard (except as specified herein) for water chillers and shall have the following minimum capacities:

Project specific equipment requirements

Nominal Capacity

Cooling capacity, minimum (full load) 1200 Tons.

Evaporator

Chilled water flow	1800 GPM
Pressure drop (maximum)	22.0 Ft.
Entering water temperature	58.0 deg. F.
Leaving water temperature	42.0 deg. F.
Maximum tube velocity	12.0 FPS
Water side working pressure	150 PSIG
Fouling factor	0.00010
Number of passes	Optional

Condenser

Condenser water flow	3600 GPM (design)
Pressure drop (maximum)	22.0 Ft.
Entering water temperature	85.0 deg. F.
Leaving water temperature	95.0 deg. F.
Maximum tube velocity	12.0 FPS
Water side working pressure	150 PSIG
Fouling factor	0.00025
Number of passes	Optional

Electrical characteristics:	Chiller	Starter
	480v/3 ph/60 Hz	480 volt

Sound Table:

% Load	dB,A Weighted
100	90
25	92

PART 3 - EXECUTION

FACTORY ACCEPTANCE TESTING

Each chiller shall be run-tested in accordance with ARI Standards using an ARI-approved test stand in the manufacturer's factory or laboratory. The test shall simulate full- and part-load conditions to check performance (capacity and energy consumption), noise, vibration and operating/safety controls.

The Engineer and Owner's Representative shall be notified to review the installation and witness the factory test. The Owner will witness testing only during normal working hours.

The vendor shall submit for approval before scheduling the testing procedures including the following:

* Data sheets showing the acceptable maximum/minimum points as well as the anticipated values.
* The test load points with guaranteed KW/ton (include corrections for open-drive motors and/or variable-speed drives as well as fouling factors).
* Test equipment.
* Overall schedule
* Test stand layout.
* Activity schedule
* Vibration testing methods

Unless the test results are in complete conformance with the requirements stated herein, the Owner will not accept the chillers or authorize the chillers to be shipped from the factory.

If the equipment fails to perform within allowable specified tolerances, the manufacturer may make necessary revisions to the equipment and retest as required. If necessary to extend the testing period by additional day(s), and/or make return trip(s) to the test site, the manufacturer shall assume all expenses incurred by the Owner and/or his representative to witness the retest.

Full Load Capacity Test: Chiller shall be tested at full load to verify the tonnage produced and the KW/Ton consumed. The chiller shall meet or exceed 100% of the specified minimum cooling tons required. No ARI tolerances will be acceptable for the specified minimum cooling tons.

Full Load Efficiency Test: The chiller shall meet 100% of the maximum KW-per-ton value that manufacturer submitted on the life cycle cost bid form. No ARI tolerances will be acceptable for the full load KW-per-ton value.

Partial-Load Efficiency Tests: Chiller shall be tested at three additional partial-load points, chosen in advance by the owner from the points listed in the Form of Proposal. No ARI tolerances will be acceptable for the partial-load KW/ton values.

Maintain constant leaving chilled water temperature and entering condensing water temperature as listed in the energy cost analysis chart of the Form of Proposal.

BEARING VIBRATION TEST – The vendor shall test, monitor, record, and analyze the vibration levels of each chiller bearing on the following occasions:

* As part of factory acceptance testing
* After initial installation/start-up
* At least two (2) months prior to the end of the chiller warranty period.

Vibration Test Methods: The vendor shall monitor and record the vibration levels of the horizontal and vertical axes of all chiller bearings. Additionally, the vendor shall monitor and record the axial vibration levels of outboard chiller bearings. The vendor shall permanently locate all transducer attachment points on the chiller during the factory acceptance tests. These transducer attachment points are to be used during subsequent vibration monitoring tests performed in the field. The vibration test shall be a narrowband test. The results shall be reported in peak velocity (in./sec.) vs. frequency.

Vibration Test Procedures: All vibration tests shall be performed in accordance with approved vibration test procedures. The vendor shall submit both factory acceptance test and field test procedures to the owner for review/concurrence with the equipment submittals. The vibration test procedures shall identify the test equipment setup and test methods to be utilized.

Documentation and Analysis: The vendor shall summarize the results of each vibration test in a vibration test report. The final test report shall compare the results of field tests with the test results obtained from factory acceptance testing. The vendor shall provide the owner with a written assessment of the acceptability of the test results and recommend how often future vibration tests should be performed in order to monitor chiller performance in a cost effective manner. The vendor shall also identify vibration levels that

are considered by the vendor to warrant specific corrective actions.

Sound Pressure Test -- Each chiller shall have sound tests conducted at the factory prior to shipment to confirm the Sound Pressure Levels as listed herein. All data must be measured and presented in strict accordance with ARI Standard 575-94.

The sound data points shall be measured simultaneously during the factory verification of capacity and efficiency. Sound tests will be run at 100% and 25% load points. If the 25% load point is not one selected by the owner for acceptance, an additional test at 25%/85 deg. EWT will be performed for sound testing only. The chiller must not surge during this test condition.

In the event that a chiller does not meet the submitted dBA sound pressure level, the manufacturer must, at his expense, provide sufficient attenuation to the machine to meet the submitted value. This attenuation shall be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller.

If the unit cannot be modified to meet the submitted sound levels, unit will be rejected.

Final Testing Report: Provide to the Owner's representative and the Consulting Engineer a factory-certified test report, certifying that the proposed chillers perform as specified.

PRODUCT DELIVERY AND HANDLING

Handle water chiller and components carefully to prevent damage, breaking, denting and scoring. Do not ship damaged water chiller or components; replace with new.

Ship the entire refrigerant charge in separate containers.

INSTALLATION

Supervision: Inspect the chillers for “as-arrived” condition and confirm suitable condition for installation. Supervise unloading of the chillers by the installing contractor.

Coordination: The vendor shall have a service technician present when the chiller components are rigged into the mechanical room by installing contractor. The installing contractor shall have a representative present when the chiller is disassembled and

reassembled by vendor, when required for ingress.

Start-Up:

Chiller and accessories shall be installed, tested, evacuated, dehydrated and charged under the direct supervision of a manufacturer-trained service engineer (“factory engineer”). The factory engineer shall be present at all progress meetings and be present during all erection, calibration, evacuation/charging and the initial operation of each water chiller.

Furnish and install the initial charge of refrigerant and oil.

Test and adjust chiller controls and safeties. Lubricate rotating parts. Verify that motor amperage conforms to manufacturer's data.

After the chiller has been thoroughly tested and is running, the factory engineer will provide 24 hours operation based on three 8-hour days for each chiller. The factory service engineer shall log all operating conditions each hour during the 24 hours of operation and submit the logs to the Engineer for his review and approval.

The 24 hours will include instructing the Owner's representative and familiarizing the Owner in the correct means of logging all pressures and temperatures in connection with the chiller. The manufacturer's service engineer shall visit the job three (3) times per year during the Warranty period: summer, spring, or fall and winter after acceptance for any adjustments necessary for proper operation.

Demonstration for Owner: Provide two separate sessions with the factory engineer to demonstrate and train Owner's personnel as specified below:

Start chiller and verify performance. Demonstrate operation to Owner.

Train Owner's personnel on procedures and schedules for startup, shutdown, troubleshooting, servicing, and preventive maintenance.

Review data in operating and maintenance manuals.

Schedule training with the Owner through the Engineer with at least 7 days' notice.

WARRANTY

Warranty: Warranty services for the chiller equipment, as specified herein, are to be performed directly for the owner. The installing

contractor is only responsible for warranty items that are directly associated with the installation (i.e. not the chiller performance).

The manufacturer shall provide a five-year parts and labor warranty for the entire chiller assembly, including starter and controls.

The warranty shall commence upon substantial completion for each chiller.

The manufacturer's representative will have a service engineer available to service any breakdown in 24 hours after notification, and the number of trips will not be limited during the warranty.

Shared-Refrigeration Circuits with Dual Compressors: For dual compressor chiller designs where two compressors share a single (common) refrigeration circuit, the entire refrigerant and oil charges and both compressor/motor assemblies shall be replaced in the event of a failure of either compressor/motor assembly.

Refrigerant Loss: The manufacturer shall replace at no expense to the Owner any loss of refrigerant and oil (unless due to negligence of the Owner) during a five-year period from the date of substantial completion.

MAINTENANCE AGREEMENT

The chiller manufacturer shall include a five-year maintenance agreement for each of the chiller(s). The maintenance agreement shall include a minimum of three (3) eight-hour inspections each year of operation for each of the chiller(s). The costs for all materials, parts, oil, oil filters, refrigerant, gaskets, shaft seals, O-rings, couplings, etc., for each year maintenance agreement shall be included. Each inspection shall include a written standardized service and maintenance report indicating all items checked and serviced. Signed reports shall be submitted to the Owner for review and approval at the end of each inspection. Reports shall note any irregularities in operation of each system and tracked over time in an attempt to predict component replacement and/or downtime.

Each Yearly Maintenance Service shall include the following:

Electrical System Check: Operational verification of relays, overload dashpot fluid level, starter contacts, tightening of power wiring, and megohmeter test of compressor motor(s), and overload calibration.

Machine Safety Control Check: Calibration of all unit safety control devices.

Lubrication System Service: All oil filter changes, inspection of oil heater, oil cooler, pressure regulator, and heater controls, to be performed at end of first cooling season and each year thereafter.

Purge Service: Provide service as recommended by the purge unit manufacturer's written recommendations, including replacement of dryers and cores.

Refrigerant Charge Service: The chiller shall be checked for proper refrigerant charge at each of the specified inspections. Refrigerant shall be added as required at no charge to the Owner.

Shaft Seal Service: The compressor motor shaft seal(s)of open motor driven chillers shall be tested for refrigerant and excessive oil leakage in the presence of the Owner at each of the specified inspections. "Excessive" is defined as exceeding 8 oz. of oil/refrigerant per 1000 hours of operation.

Drive Alignment Service: The alignment of open-drive chillers and couplings shall be checked at each of the specified inspections.

Speed-Increasing Gear Set Service: The speed-increasing gear set shall be checked at each of the specified inspections.

Condenser Tube Service: Condenser heads shall be removed at both ends of the chiller. Tubes and tube sheets shall be inspected for fouling.

Additional Training

Provide follow-up personnel training during service period:

Operator's Log - A review of the operator's logs and the operator's experience with recent operation shall be done at each of the specified inspections to address any concerns.

Unit Log - A log of all temperatures, pressures, amperage, and voltage shall be done at each of the specified inspections.

The following items shall be done at **each** of the specified inspections while the chiller is operational:

Adjust operating and safety controls as required and record settings.
Complete operating log of temperatures, pressures, voltages, and amperages to determine unit-operating efficiency.

Check operation of purge system.

Check operation of control circuit.

Check operation of lubrication system including oil pump and oil pressure regulator. The chiller manufacturer's field supervisor shall submit a written report.

Check operation of motor and motor starter.

Check customer's log with operator and discuss operation of the chiller(s) in general.

An ASHRAE Guideline 3 Report shall be reviewed with the Owner at each of the specified inspections by the manufacturer's field supervisor. The report shall be signed by the chiller manufacturer's field supervisor and given to the Owner for his records.

Oil Analysis Service - After the first cooling season, and annually thereafter, oil analysis shall be performed, measuring acid, moisture, and wear metals content. The manufacturer shall review the laboratory results and submit a written report.

Refrigerant Analysis Service - An analysis of the refrigerant shall be performed annually measuring acid, moisture content, and check for system contamination. The manufacturer's field supervisor shall make a review of the laboratory results and a written report shall be submitted.

Vibration Analysis Service – After the first cooling season, and annually thereafter, a vibration test/analysis shall be performed per the above referenced Bearing Vibration Testing procedures. The manufacturer shall review the results and submit a written report.

END OF SECTION 236416